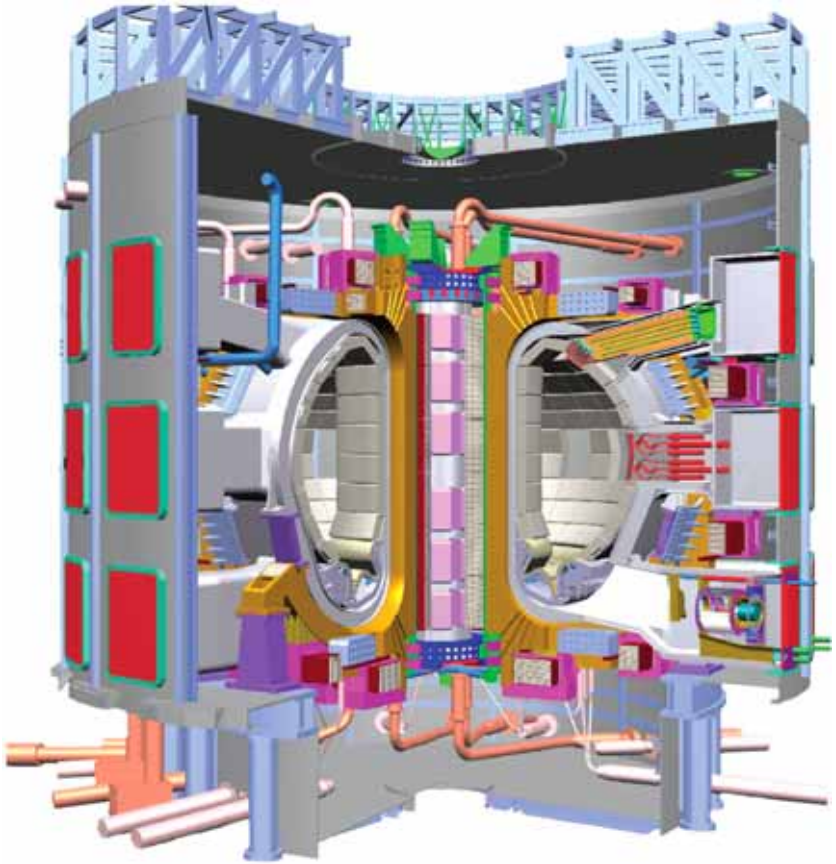
Plans for Community Participation in the ITER Project



Ned Sauthoff

OFES Budget Planning Meeting

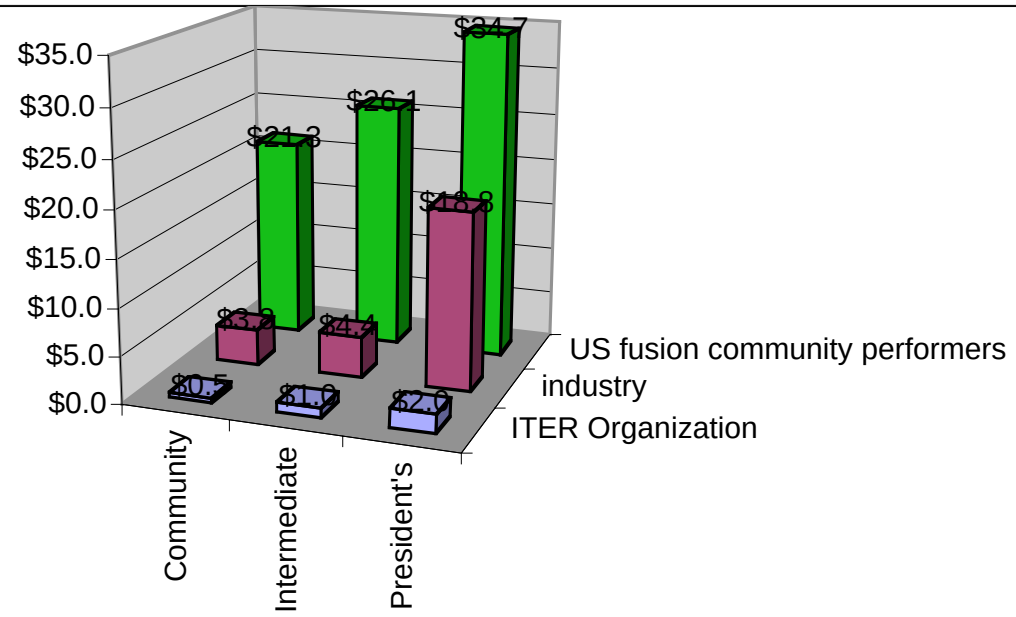
March 16, 2005

Outline

- **Project activities and opportunities**
  - Scopes
  - Task Requests from the International Team
  - Selection of performers for project work

- **Project interface with the Burning Plasma Program**
  - Structure
  - Scope
    - ITPA high priority R&D topics
    - Physics Task Requests

Distributions among performers in FY06: US fusion community, industry, and ITER Org ($M)



	Community	Intermediate	President's
ITER Organization	$0.5	$1.0	$2.0
industry	$3.8	$4.4	$18.8
US fusion community performers	$21.3	$26.1	$34.7

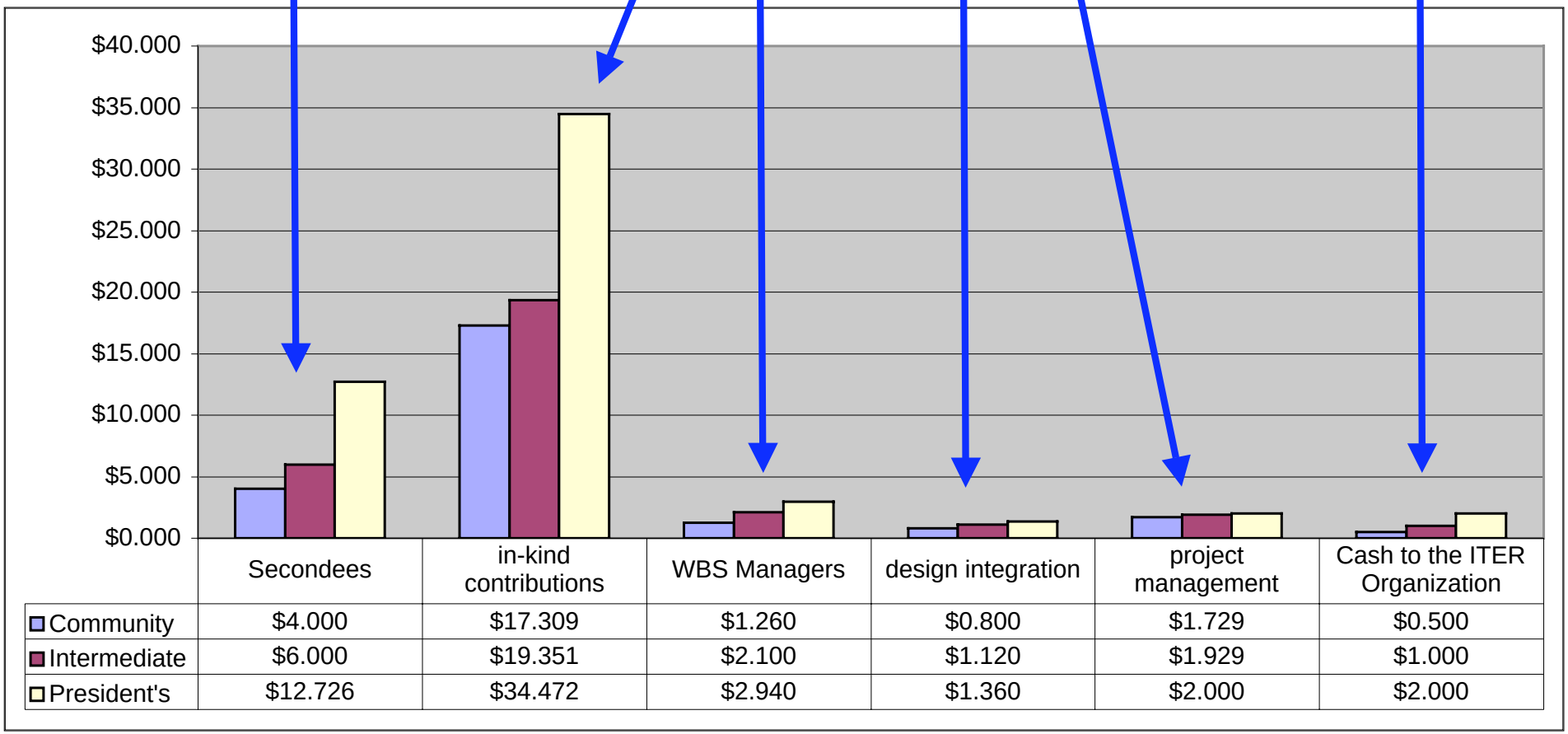
- **Fusion community performers (including secondees) receive the majority of the resources in all 3 FY06 cases ($21M, $26M, and $35M)**
- **Industry receives a major fraction only in "President's case"**
- **Cash for the ITER Organization is small in all cases**

Magnitudes of FY06 budgets ($M) in major areas of contribution

Staff for the ITER Organization

In-kind contributions (R&D, design, fabrication, oversight, and delivery)

Cash to the ITER Organization



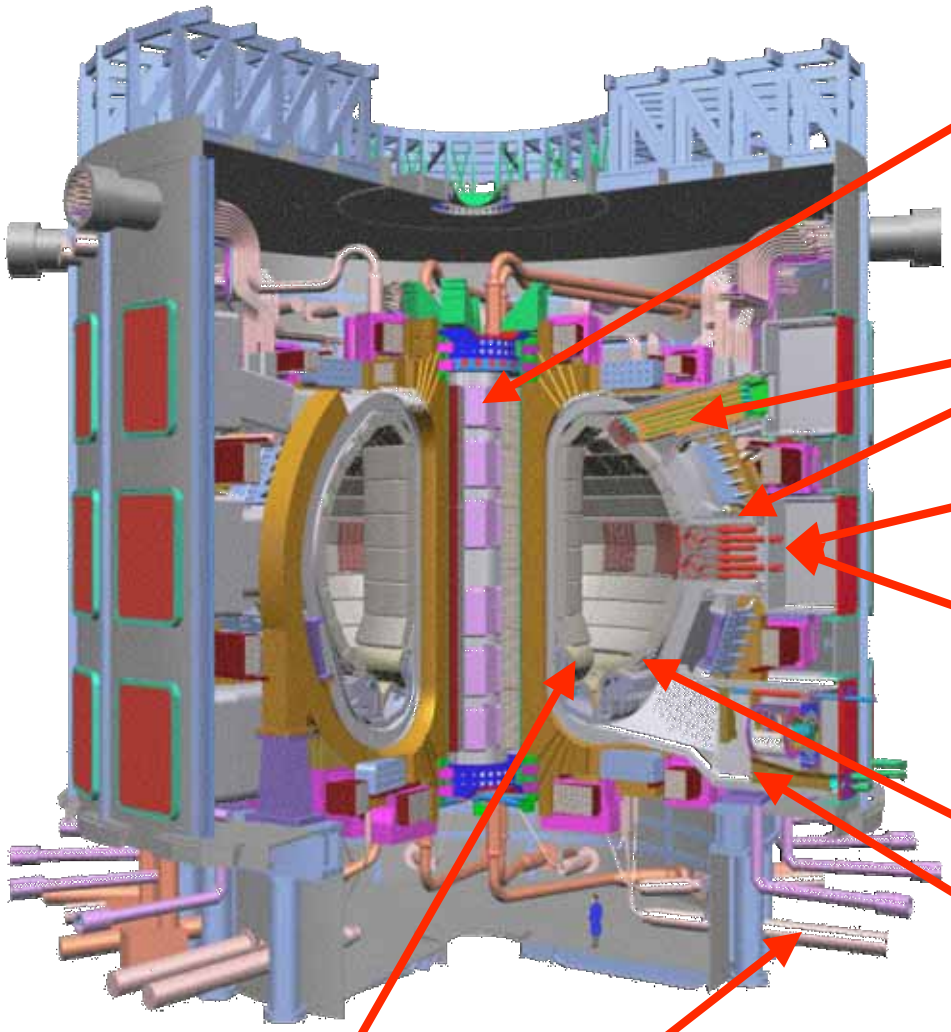
	Secondees	in-kind contributions	WBS Managers	design integration	project management	Cash to the ITER Organization
Community	$4.000	$17.309	$1.260	$0.800	$1.729	$0.500
Intermediate	$6.000	$19.351	$2.100	$1.120	$1.929	$1.000
President's	$12.726	$34.472	$2.940	$1.360	$2.000	$2.000

Professional Staff reporting to the ITER Organization

- **US allocation: 180 person years over 8 years (~ 23 FTEs)**
  - Note: could be reduced if some Central Team functions are performed by integrated construction management organization

- **Selection process**
  - **ITER Organization** distributes position descriptions to the Domestic Agencies and requests candidates
    (Note: there may be “term limits” and requirements for “return ticket”)
  - **Domestic agency**, working with DOE and US community:
    - Decides whether to offer a candidate for that position and conditions
    - If so, solicits request for candidates, receives responses and prepares US response to the ITER Organization’s request
    - Note: Organizational Conflict of Interest have to be managed
  - **ITER Organization** selects from the pool of applicants and makes arrangements with the Domestic Agency to provide the staff member.
    Possible arrangements could include:
    - Direct employment by the ITER Organization
    - Secondment

Provisional US In-kind Contributions



(4 or 7) of 7 Central Solenoid Modules

Steady-state power supplies

15% of port-based diagnostic packages

44% of ICRH antenna + all transmission lines, RF-sources, and power supplies

Start-up gyrotrons, all transmission lines and power supplies

Baffle (Module 18)

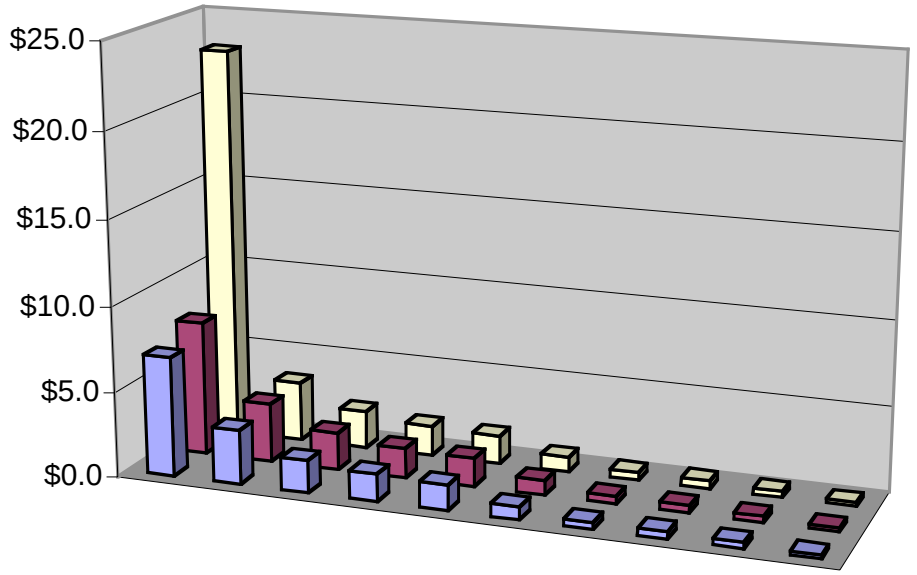
Roughing pumps, standard components

Tokamak exhaust processing system

pellet injector

(1 or 0) Cooling for divertor, vacuum vessel, …

in-kind contributions in FY06 ($M)



	magnet	blanket/ shield/ PFC	diagnostics	ECH	ICH	Tritium	cooling water	steady state power	vacuum/ fueling	safety
Community	$7.0	$3.2	$1.9	$1.6	$1.5	$0.8	$0.4	$0.4	$0.4	$0.2
Intermediate	$7.9	$3.5	$2.2	$1.8	$1.7	$0.9	$0.5	$0.5	$0.4	$0.2
President's	$23.0	$3.5	$2.2	$1.8	$1.7	$0.9	$0.5	$0.5	$0.4	$0.2

How would the fusion community be engaged in community-scopes totaling ~$21M-$34M in FY06?

Magnet design	~$3.5M
Blanket/shield design	~$3M
Diagnostic design (instruments + plugs)	~$2M
Electron cyclotron design	~$1.5M
Ion cyclotron design	~$1.5M
Tritium processing design	~$0.8M
Vacuum/fuelling design	~$0.3M
Cooling water design	~$0.3M
Steady-State Electric Power	~$0.3M
Safety	~$0.2M
Secondees	~$4-13M
Design Integration	~$1M
WBS managers	~$1-3M
Project management	~$2M

Outline

- **Project activities and opportunities**
  - Scopes
  - Task Requests from the International Team
  - Selection of performers for project work

- **Project interface with the Burning Plasma Program**
  - Structure
  - Scope
    - ITPA high priority R&D topics
    - Physics Task Requests

Task Requests from the ITER International Team

- **During the ITER Construction Phase, work on in-kind contributions will be governed by Procurement Agreements**
  - ITER Organization defines specifications (functional, performance, or build-to-print) and arrangements for the work, including roles for the Field Team:
    - approval of vendor qualification
    - approval of contract
    - intermediate inspections and approvals for progress-payments
    - final acceptance
    - delivery
  - Domestic Agency works with ITER Organization to reach agreement

- **During the current ITER Transitional Arrangements, formal coordination of technical work between the parties and the International Team is through Task Agreements**
  - The ITER International Team Leader issues Tasks Requests, regarding scope of work, interface with the ITER International Team, and Final Reporting
  - Participant Team Leader refines request and works toward agreement
  - The Participant Team can also propose tasks

International Team Task Requests to the US: Magnet

- **Strand**
  - Qualification of industrial supplies of Nb_3Sn strands with increased value of J_c
- **Jacket**
  - Mechanical Characterization of CS Jacket Materials
  - CS jacket weld defect assessment
  - Butt Joint Test before and after Applied Tensile Strain
- **Cable**
  - Manufacture and test of Nb_3Sn Prototype conductor samples (Sultan type) for the TF and CS coils
  - Degradation investigations on Nb_3Sn conductors
  - Conductor performance and design criteria (transverse load effects)
  - AC Loss Measurements on Full Size Conductors (final configuration)
- **Coil**
  - Structural Analysis of the CS Coils (global and detailed)
  - Stress analysis of the helium inlet regions
  - Mechanical test of sections of CS He inlets and joint links

International Team Task Requests to the US: First Wall and Blankets

- **First Wall**
  - Development of FW fabrication methods to reduce cost
  - Qualification of the FW panel fabrication methods and to establish the NDT method for the FW panel.
  - Development of the welded joint for the first wall leg, suited for cut and re-welding in the Hot Cell
  - Analysis of erosion of the ITER first wall due to plasma impingement

- **Shield**
  - Detailed design of blanket modules and thermal hydraulic analysis of the blanket module 18 (BM 18).
  - Improve shield block fabrication to reduce cost
  - Design of the outboard blanket module below the equatorial ports
  - EM Analysis of improved design and dynamic structural analysis of the keys and flexible supports

International Team Task Requests to the US: Divertor

- **Continue investigation of mixed-material effects.**
- **Conceptual study of ELM suppression with RMP (Resonance Magnetic Perturbation) on ITER and RWM stabilization system for ITER.**

International Team Task Requests to the US: Fuelling

- **Detailed design of pellet injection system**
- **ITER class screw extruder mockup**

International Team Task Requests to the US: Tritium Plant

- **Detailed design and integration into overall fuel cycle of tokamak exhaust processing system based on the existing design**

- **Detailed design of Tokamak Exhaust Processing system**

International Team Task Requests to the US: Ion Cyclotron H&CD

- ICH Antenna Design Support
- Radiation/Shielding Analysis Support for ICH Antenna Designs
- Faraday Shield Design
- Mockup of 3-strap-to-one-feed current strap junction (common for all antenna concept)
- Radiation effects R&D
  (RF characteristics instead of DC)
- RF Source R&D

International Team Task Requests to the US: Diagnostics

- **Contribute to a Port Engineering Task Force (one or two members per PT) to determine the guiding principles for the design and engineering of the diagnostic ports.**

- **Support the ITER IT in the writing of procurement specifications for diagnostic port-based procurement packages.**

International Team Task Requests to the US: System Engineering and Analysis

- **Development and testing of a CAD (CATIA V5 or STEP files)-MCNP interface programs for ITER neutronics design calculations**

International Team Task Requests to the US: Materials

- New revision of the ITER Materials Properties Handbook
- R&D in support of material qualification
- Support of materials activity

International Team Task Requests to the US: Safety

- **Dust Characterization, Mobilization and Transport**
- **Magnet safety**
- **Safety Code Support**

International Team Task Requests to the US: Physics [SPECIAL CASE]

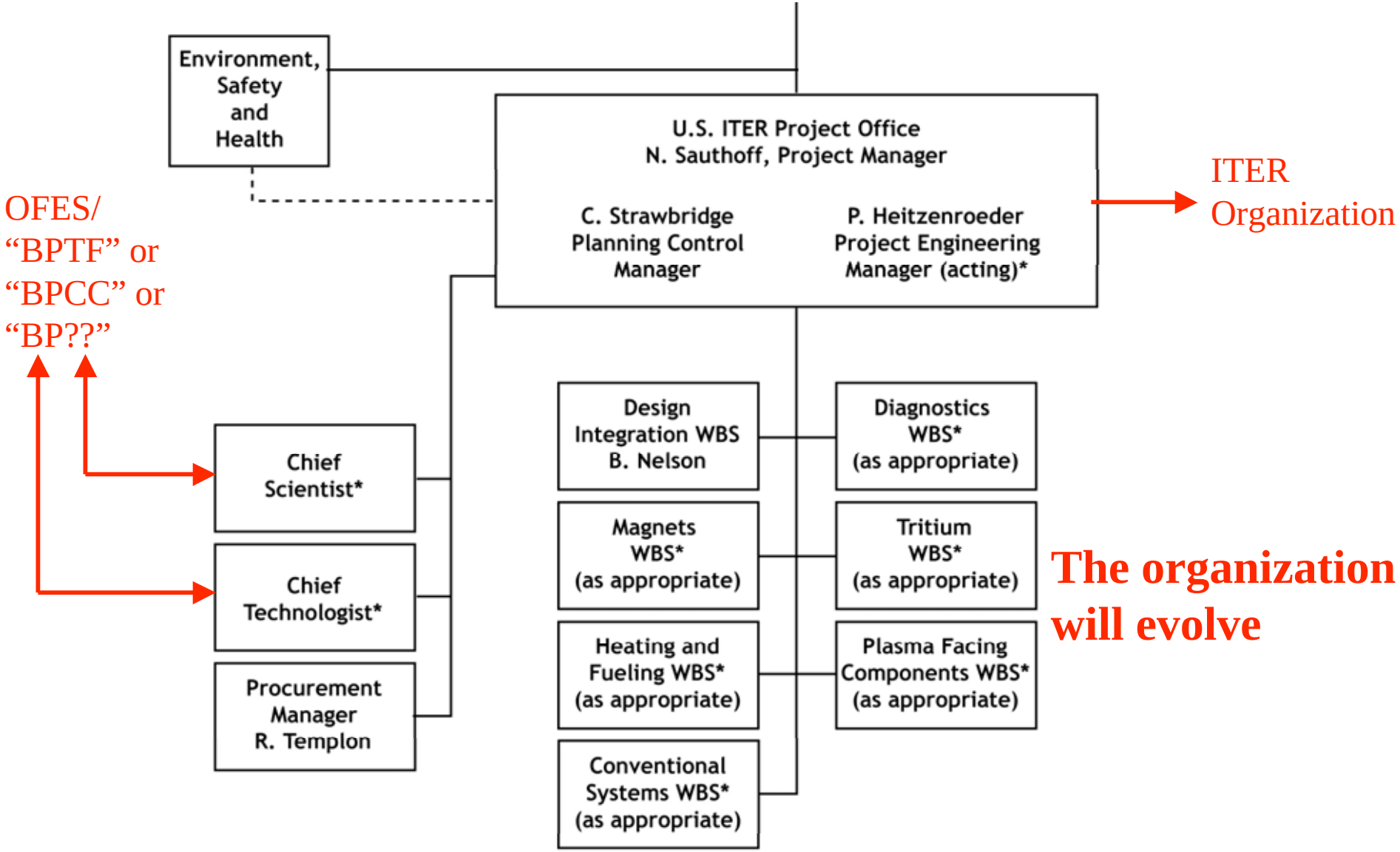
- **RWM control in ITER Steady State Scenarios**
- **Divertor Opacity and Radiation Transfer**
  - Assess the physics in current codes to properly predict the effects of opacity and radiation transfer on divertor plasma solutions for ITER
  - Assess the effects of radiation transfer on the ITER divertor solution
- **Evaluation of Fast Particle Confinement of ITER**
- **Evaluation of the effect of fishbone oscillations, TAE modes and toroidal ripple on the fast particle loss**
- **Benchmarking of ICRF codes on ITER plasma and antenna**

Outline

- **Project activities and opportunities**
  - Scopes
  - Task Requests from the International Team
  - Selection of performers for project work

- **Project interface with the Burning Plasma Program**
  - Structure
  - Scope
    - ITPA high priority R&D topics
    - Physics Task Requests

U.S. ITER Project Office



The organization will evolve

** National search will be conducted to assure best qualified individual is available to the project.*

Selections of Performers

- **Selection of senior managers**
- **Procurement of R&D and design activities**
- **Procurement of manufacturing design, prototyping, fabrication and assembly activities**

Principles for Selection of Performers

- **Project success**
  - Expertise in the technical area and in project management (as appropriate)
  - Ability to conduct work with assurance
  - Ability to deliver quality product, on schedule, and at an attractive price
  - Cost reporting
  - Earned value reporting
  - Qualification of performers' institutional systems
  - Institutional commitment (documented by formal Memoranda of Agreement)

- **Opportunity for full community participation**

Selection of senior managers

- **Selection of senior managers is a personnel action:**

  the process can select from universities, industry, labs, and individuals in an integrated action;
  the manager would likely be seconded to the US ITER Project from the present employer

- **Project defines and advertises the position**

- **Team assesses applications, with DOE oversight**

- **USIPAC review**

- **Project makes offer - in most cases as a secondment**

Procurement of R&D and design activities

- **Scope of work is defined by the Project**

- **The Project decides whether the scope is to be performed inside the DOE Lab system or outside the DOE-Lab system via "Make-versus-Buy" decision process based on**
  - FARs/DEARs
  - input from the USIPAC, and
  - approval by DOE

- **If outside the lab system (universities, industry, …), follow standard procurement rules**
  - In most cases, will use a "best value" evaluation criteria

- **If inside the lab system, the Project**
  - invites expressions of interest, and
  - selects the performers, with review by DOE
  - a decision to perform work at PPPL or ORNL requires approval of DOE

Procurement of manufacturing design, prototyping, fabrication and assembly activities

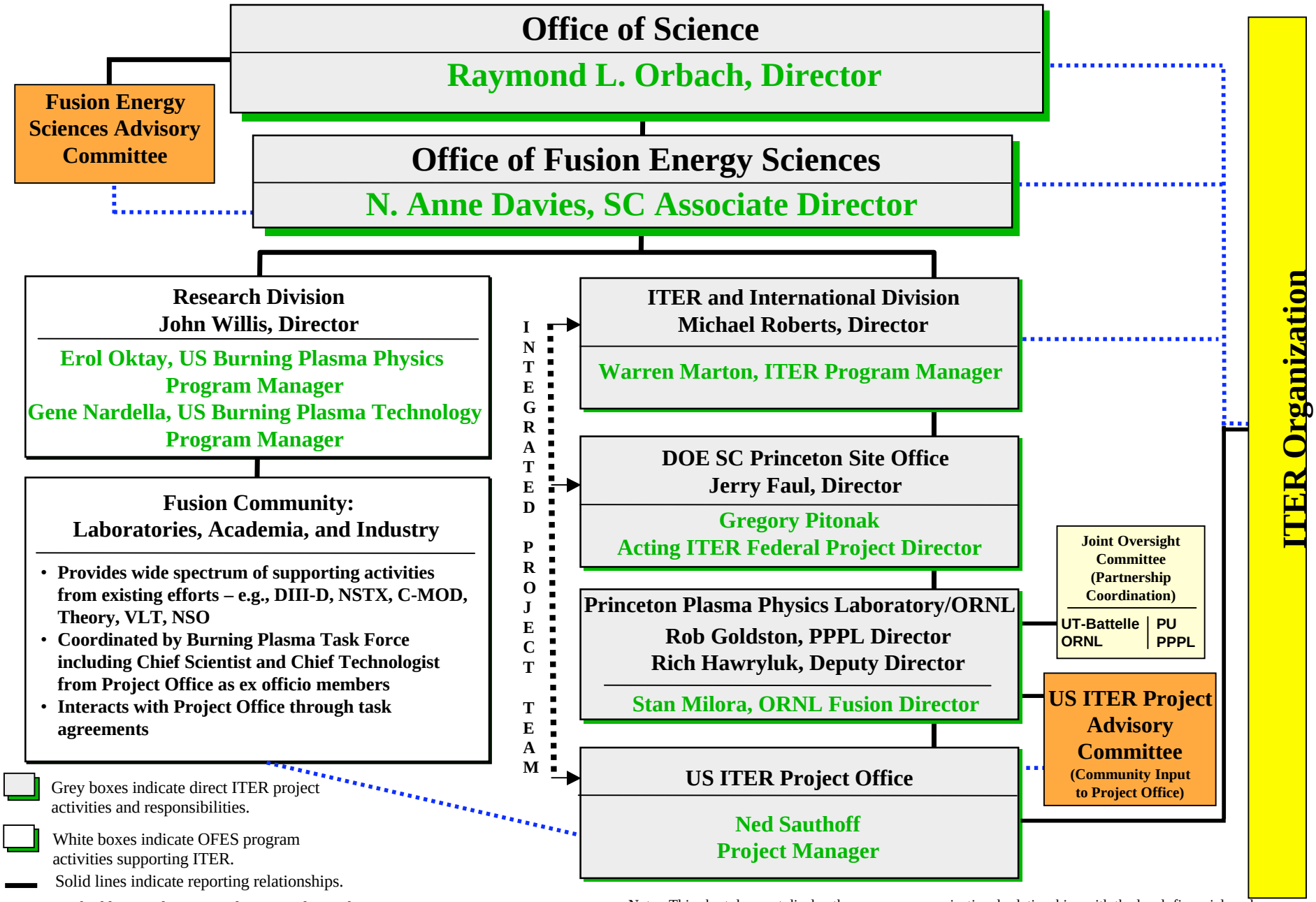
- **Develop "procurement analysis" to determine if to be sourced from labs or from universities/industry**
  - Bias towards using universities/industry, except when R&D scope is fusion-specific within DOE laboratories' defined missions
- **Utilization of Universities/ Industry where Universities/ Industries have the required expertise and the national laboratories do not**
  - Recommendation to DOE based on "make vs. buy" analysis
- **A recommendation to perform work at PPPL or ORNL requires approval of DOE**

Outline

- **Project activities and opportunities**
  - Scopes
  - Task Requests from the International Team
  - Selection of performers for project work

- **Project interface with the Burning Plasma Program**
  - Structure
  - Scope
    - ITPA high priority R&D topics
    - Physics Task Requests

Management Structure for the US ITER Project and Program



Note: This chart does not display the necessary organizational relationships with the legal, financial, and construction management offices within DOE.

Integration of the US ITER Activities and the US Community

- **The US ITER activities should involve both the US ITER Project and the US Burning Plasma Program**
  - The **project** focuses on effective execution of the fabrication and delivery of hardware, the staff and the cash contributions
  - The **program** focuses on increasing understanding of burning plasma research topics, using present and future facilities

- **The US ITER Project needs to**
  - Obtain physics and technology input on the ITER-design issues
  - Engage the US community in the ITER project activity
  - Position the US community for the research phase by strategic project activity
  - Work with the US community on Physics Tasks, especially research tasks

- **We are seeking to develop vehicles for bi-directional communications with the Community**
  - The US Burning Plasma Task Force/Coordinating Committee is key!

ITPA participation

- **The International Tokamak Physics Activity (ITPA) is a vehicle for coordinated research on key research topics**
- **The IEA Tokamak Cooperation collaborations are formally structuring joint experiments to address high priority R&D topics**
- **The US participation in the ITPA is open to the community, even though there are quotas for “official members”**

US ITPA memberships

Coordinating Committee (CC)	Oktay
Erol Oktay	**OFES**
Ned Sauthoff	**PPPL**
Ron Stambaugh	**GA**

MHD	Dagazian
Ted Strait	**GA**
William Heidbrink	**UCI**
Robert Granetz	**MIT**
Jon Menard	**PPPL**
Gerry Navratil	**Columbia**
Ed Lazarus-Stellarator	**ORNL**
Chris Hegna	Wisconsin
Eric Frederickson	PPPL
John Wesley	GA
Steve Jardin	PPPL
Boris Breizman	Texas
Raffi Nazikian	PPPL
Doug Darrow	PPPL
Nicolai Gorelenko	PPPL
Steve Sabbagh	Columbia

Steady State Ops (SSO)	Oktay
Tim Luce	**GA**
Paul Bonoli	**MIT**
Ron Prater	**GA**
Chuck Kessel	**PPPL**
Masanori Murakami	**ORNL**
Randy Wilson	PPPL
Mike Zarnstorff	PPPL
Pete Politzer	GA
Joel Hosea	PPPL
Cary Forest	Wisconsin U

Confinement, Database, and Modeling (CDBM)	Eckstrand
Wayne Houlberg	**ORNL**
Jim DeBoo	**GA**
Stan Kaye	**PPPL**
Joe Snipes	**MIT**
Robert Budny	**PPPL**
Tom Casper	LLNL
Craig Petty	GA
Lynda Lodestro	LLNL
Glenn Bateman	Lehigh
Dale Meade	PPPL
Arnold Kritz	Lehigh
Martin Greenwald	MIT

Diagnostics	Markevich
Dave Johnson	**PPPL**
Rejean Boivin	**GA**
Tony Peebles	**UCLA**
George McKee	**Wisconsin**
Glenn Wurden	**LANL**
Don Hillis	ORNL
Ray Fisher	GA
Ken Young	PPPL
Jim Terry	MIT

Scrape-off-layer & Divertor Physics (DSOL)	Finfgeld
Bruce Lipschultz	**MIT**
Peter Stangeby	**LLNL/GA**
Dennis Whyte	**Wisconsin**
Sergei Krasheninnikov	**UCSD**
Max Fenstermacher	**LLNL**
Rajesh Maingi	ORNL
Ali Mahdavi	GA
Daren Stotler	PPPL
John Hogan	ORNL
Gary Porter	LLNL
Charles Skinner	PPPL
Henry Kugel	PPPL
Jim Strachan	PPPL
M. Groth	LLNL
Steve Lisgo	MIT

Transport Physics (TP)	Bolton
Ed Doyle	**UCLA**
Ed Synakowski	**PPPL**
John Rice	**MIT**
John Kinsey	**Lehigh**
Punit Gohil	**GA**
Dave Mikkelsen-Stell.	**PPPL**
Catherine Fiore	MIT
Larry Baylor	ORNL
Wendell Horton	Texas
Chuck Greenfield	GA
T.S. Hahm	PPPL
Bill Nevins	LLNL
Martin Peng	PPPL/ORNL
Ron Waltz	GA
Jim Callen	Wisconsin

Edge Pedestal Physics (EPP)	Crisp
Tony Leonard	**GA**
Amanda Hubbard	**MIT**
Parvez Guzdar	**Maryland**
Tom Rognlien	**LLNL**
Micky Wade	**ORNL**
Xueqaqio Xu	LLNL
Phil Snyder	GA
Rich Groebner	GA
Rip Perkins	PPPL
Tom Osborne	GA
Jim Drake	Maryland
Ben Leblanc	PPPL

ITPA: Transport Physics

- **Improve experimental characterization and understanding of critical issues for reactor relevant regimes with enhanced confinement, by:**
  - Obtaining physics documentation for transport modeling of ITER hybrid and steady-state demonstration discharges
  - Addressing reactor relevant conditions, e.g., electron heating, Te~Ti, impurities, density, edge-core interaction, low momentum input, ...

- **Contribute to and utilize international experimental ITPA database for tests of the commonality of hybrid and steady state scenario transport physics across devices**

- **Encourage tests of simulation predictions via comparisons to measurements of turbulence characteristics, code-to-code comparisons and comparisons to transport scalings**

ITPA: Confinement Database and Modelling

- **Assemble and manage multi-machine databases, analysis tools, and physics models**
- **Evaluate global and local models for plasma confinement by testing against the databases.**
- **Predict the performance of Burning Plasma Experiments using the models, and include an estimate of the uncertainty of the predictions.**

ITPA: Pedestal and Edge

- **Construct a Profile DB based on Inter machine experiment and perform tests of modeling using the profile DB as TG work.**
- **Improve predictive capability of pedestal structure through profile modelling.**
- **Construct physics-based and empirical scaling of pedestal parameters**
- **Improve predictive capability for ELM size and frequency and assess accessibility to regimes with small or no ELMs.**

ITPA: Divertor and SOL

- **Understand the effect of ELMs/disruptions on divertor and first wall structures.**
- **Improve understanding of Tritium retention & the processes that determine it.**
- **Improve understanding of SOL plasma interaction with the main chamber.**
- **Develop improved prescription of SOL perpendicular transport coefficients and boundary conditions for input to BPX modelling**

ITPA: MHD, Disruption and Control

- **Perform MHD stability analysis of H-mode edge transport barrier under Type I and tolerable ELM conditions.**
- **Investigate/Determine island onset threshold of NTMs, stabilisation of (3,2) and (2,1) NTM islands at high-b and b-recovery, and possible operation with benign NTMs (FIR, seed island control); identify requirements for reactor plasmas.**
- **Enhance understanding and mitigation of the effects of RWMs by analysis, experimental verification of control, determination of role of plasma rotation and error fields. Determination of control system requirements for diagnostics.**
- **Construct new disruption DB including conventional and advanced scenarios and heat loads on wall/targets.**
- **Develop disruption mitigation techniques, particularly by noble gas injection.**

ITPA: Steady State Operation and Energetic Particles

- **Investigate hybrid scenarios for prolonged plasma operation and develop full current drive plasmas with significant bootstrap current: assess beta limits**

- **Develop real time current profile control using heating and CD actuators: assess predictability, in particular for off-axis CD**

- **Study fast particles collective modes in low and reversed magnetic shear configurations: Identify key parameters. Perform theory-data comparison on damping and stability, including non-linear mode dynamics and fast particle transport.**

ITPA: Diagnostics

- Develop methods of measuring the energy and density distribution of confined and escaping alphas
- Review requirements for measurements of neutron/a source profile and assessment of possible methods of measurement
- Determine life-time of plasma facing mirrors used in optical systems
- Develop new methods to measure steady state magnetic fields accurately in a nuclear environment and assessment of thermal EMF on irradiated coils used for steady state magnetic field measurements
- Develop requirements for measurements of dust, and assessment of techniques for measurement of dust and erosion

International Team Task Requests to the US: Physics [SPECIAL CASE]

- **RWM control in ITER Steady State Scenarios**
- **Divertor Opacity and Radiation Transfer**
  - Assess the physics in current codes to properly predict the effects of opacity and radiation transfer on divertor plasma solutions for ITER
  - Assess the effects of radiation transfer on the ITER divertor solution
- **Evaluation of Fast Particle Confinement of ITER**
- **Evaluation of the effect of fishbone oscillations, TAE modes and toroidal ripple on the fast particle loss**
- **Benchmarking of ICRF codes on ITER plasma and antenna**

Summary…

- **Community engagement in the US ITER Project and the US Burning Plasma Program is key to achievement of US burning plasma objectives**

- **The US ITER Project seeks the best performers for doing the work**
  - physics and technology tasks for the US in-kind scope and from the ITER Team
  - partnership with the full US fusion program in the performance of the work
  - recruitment and selection of the best performers for ITER Organization staff, US ITER Project senior managers, R&D and design, and fabrication

- **Our proposed processes will be discussed at the upcoming USIPAC meeting**

- **We welcome your inputs…**